



February 21, 2019

Traffic Signal Warrant Study

Randall Street at Dock Street and Prince George Street

SABRA
& ASSOCIATES



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EXECUTIVE SUMMARY

A traffic study was performed for the intersections of **Randall Street and Dock Street** and **Randall Street and Prince George Street** in Annapolis, MD. For each intersection, the study evaluated the need for a full color traffic signal, stop-control, alternative geometric configurations, and other traffic safety measures. The study was performed in accordance with the Maryland Manual on Uniform Traffic Control Devices (MD-MUTCD), 2011, the Institute of Transportation Engineers (ITE) Manual on Traffic Engineering Studies, and the American Association of State Highway and Transportation Officials (AASHTO) Policy on Geometric Design of Highways and Streets, 2011.

New turning movement counts were collected in October 2018. Crash data was compiled and analyzed from the Maryland DOT State Highway Administration Office of Traffic and Safety for the most recent three-year period. Sight distance, vehicle delays and queues were field measured, observations of driver and pedestrian behaviors at each intersection under the existing traffic controls were noted, and capacity analysis was performed. The analysis included peak hour volumes, intersection capacity and level of service, and signal warrant analysis.

Five different alternatives are recommended for consideration. Scenarios evaluated include:

- 1) Pretimed Traffic Signals at Randall Street and Dock Street, Randall Street and Prince George Street
- 2) Pretimed Traffic Signal at Randall Street and Dock Street, Randall Street and Prince George Street; Bump-outs with right turn channelization at Randall Street and Dock Street
- 3) Pretimed Traffic Signal at Randall Street and Dock Street, Randall Street and Prince George Street; Reducing Northbound Randall Street from Three Lanes to Two Lanes
- 4) Actuated-Coordinated Traffic Signals at Randall Street and Dock Street, Randall Street and Prince George Street
- 5) Pretimed Traffic Signal at Randall Street and Dock Street; Signal Removal/ Minor Street Stop Sign along Prince George Street at Randall Street

Based on the findings of this study and the alternatives evaluated, **Alternative 2** is recommended. In Alternative 2, traffic signal control would be constructed at Randall Street and Dock Street, with peak and non-peak pedestrian phasing, in combination with bump-outs and a channelization of the right-turn lane on the south leg of Randall Street. The existing traffic signal would remain in place at Randall Street and Prince George Street; however, a new cycle length would be programmed in coordination with the proposed signal at Randall Street and Dock Street.



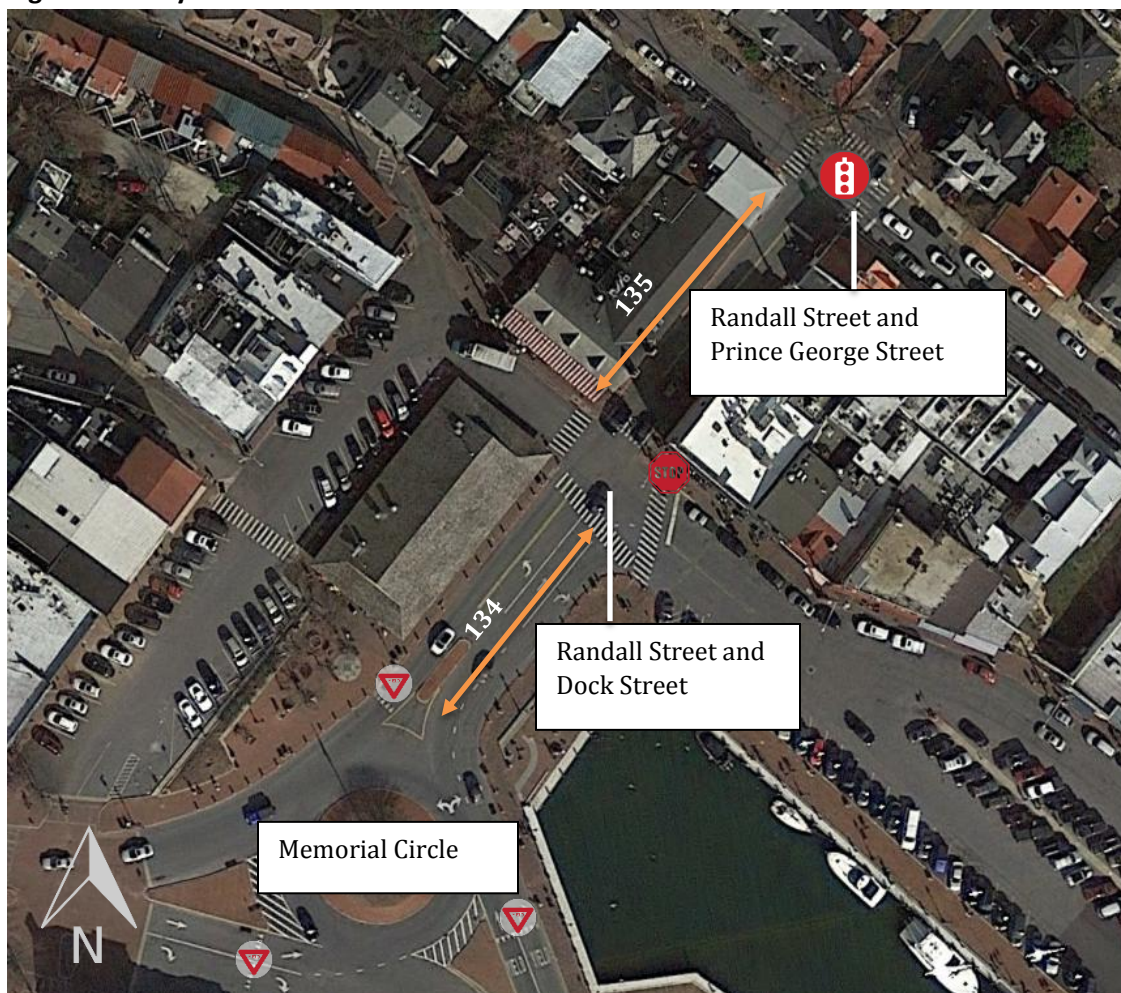
Introduction

The City of Annapolis made a request to evaluate the intersection safety and the need for a traffic signal at Randall Street and Dock Street, and at Randall Street and Prince George Street. Concern was shown for the high volume of pedestrians that conflict with vehicles at Randall Street and Dock Street.

The two study intersections were previously reviewed in the *2011 Bicycle, Automotive, and Pedestrian Safety Evaluation*. The study recommended that a traffic signal be installed at Randall Street and Dock Street along with geometric improvements to reduce pedestrian crossing distances and minimize pedestrian and vehicle conflicts. According to the 2011 study, a new traffic signal would improve pedestrian access to the waterfront, reduce conflict with vehicles, and divert traffic from Prince George Street. An exclusive pedestrian phase, which allows easier egress from Market Place and Annapolis City Dock via Dock Street, was considered as well.

The present safety study and signal warrant analysis will be used to determine if there is a need for the installation of a signal at Randall Street and Dock Street, as well as if the existing traffic signal at Randall Street and Prince George Street is still warranted and could be removed. An area map of the study area is shown in **Figure 1**.

Figure 1: Study Area





Site Description

The study area consists of the intersections of Randall Street at Dock Street, Randall Street at Prince George Street, the Memorial Circle roundabout, and the roadways in between these intersections. Randall Street is a four-lane street south of Dock Street, and a two-lane street north of Dock Street. It generally travels northeast/southwest direction but will be referred to as a north/south roadway for the purposes of this study. Dock Street is a two-lane street that is oriented northwest/southeast direction but will be referred to as an east/west route in this study. Prince George Street is a one-lane, one-way street in the northwest direction but will be referred to as an east/west roadway in this study. Time-restricted parking is present on the east and west legs of Dock Street, the east and west legs of Prince George Street, and on Randall Street north of Prince George Street. Each approach of Randall Street and Dock Street has a marked crosswalk with ladder striping; three legs of the intersection at Randall Street and Prince George Street have marked crosswalks. There is 150 feet between the two intersections of Dock Street and Prince George Street along Randall Street. Memorial Circle is 170 feet south of Dock Street.

The study area is adjacent to Annapolis City Dock, the historic heart of Annapolis. Land uses include restaurants, cafes, retail, hotels, and public space. There is a bike share facility located south of the intersection of Randall Street and Dock Street, north of Memorial Circle. Both Annapolis Elementary School and St. Mary's Elementary School and High School are located within a quarter mile of the study area.

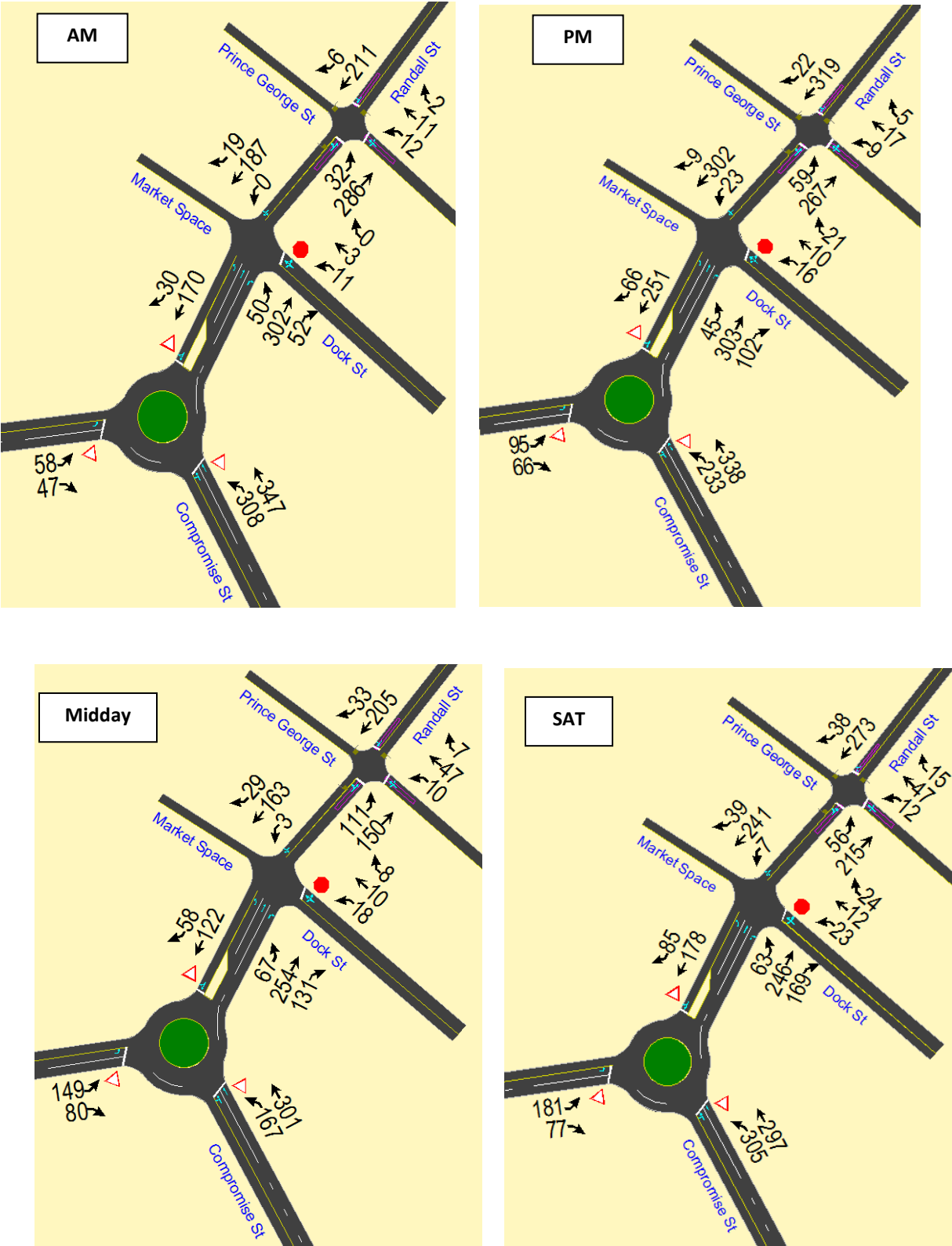
Findings

Weekday traffic counts were performed on Thursday, October 18, 2018, at the intersections of Randall Street and Dock Street, Randall Street and Prince George Street, and Memorial Circle, with all nearby schools in session. Saturday traffic counts were performed on October 20, 2018. A peak hour is defined as the four consecutive 15-minute intervals with the highest observed traffic volumes. Peak hour volumes for each intersection were used for analysis.

- 1) **Peak Hours:** During the weekday, the AM and PM peak hours occurred between 7:45 AM and 8:45 AM and from 5:00 PM to 6:00 PM, respectively, but the highest volume of vehicles counted occurred between 2:15 and 3:15 PM. On Saturday, the peak hour occurred between 12:00 PM and 1:00 PM, which was also the pedestrian peak hour. The weekday pedestrian peak hour occurred between 12:15 PM and 1:15 PM, which was also a vehicular surge.
- 2) **Vehicular Traffic:** Nearly 1,040 vehicles during the morning, over 1,225 vehicles during the evening, and approximately 1,220 vehicles during the Saturday peak hours entered the study area. The peak hour traffic volumes are shown in **Figure 2**.



Figure 2: Weekday AM, Weekday PM, Weekday Midday, and Saturday Peak Hour Vehicular Volumes





- 3) **Pedestrian and Bicycle Traffic:** During the thirteen hours counted over the course of a typical weekday, an average of 501 pedestrians per hour entered the intersection of Randall Street and Dock Street, and an average of 158 pedestrians per hour entered the intersection of Randall Street and Prince George Street. During the highest hour counted (12:15 PM), 1,330 pedestrians were recorded at the intersection of Randall Street and Dock Street with 813 crossing Randall Street, 252 crossing Dock Street, and 395 crossing Market Space. Meanwhile at Prince George Street, 390 pedestrians were recorded, with 222 crossing Randall Street and 168 crossing Prince George Street. The highest number of bicyclists in the street recorded in the study area was 30, southbound on Randall Street, between 4:00 PM and 5:00 PM on a weekday. At each of the vehicular peak hours, the volumes of bicyclists recorded were 3 (AM Peak), 17 (PM Peak), and 8 (Saturday Peak). An average of 149 school-age children per hour entered the intersection of Randall Street and Dock Street during the week, while 134 school-age children entered the intersection per hour on Saturday. The peak hour for schoolchildren (someone appearing to be between 5 and 18 years age) crossing at Randall Street and Dock Street was 12:00 PM during the week (372 school-age children) and 1:00 PM on Saturday (274 school-age children). **Figures 3, 4, and 5** show the total crosswalk volumes during the morning, evening, and Saturday peak hours. **Figure 6** shows the total crosswalk volumes during the weekday pedestrian peak.

Figure 3: Total Pedestrian Volumes, AM peak vehicle hour (7:45 AM)

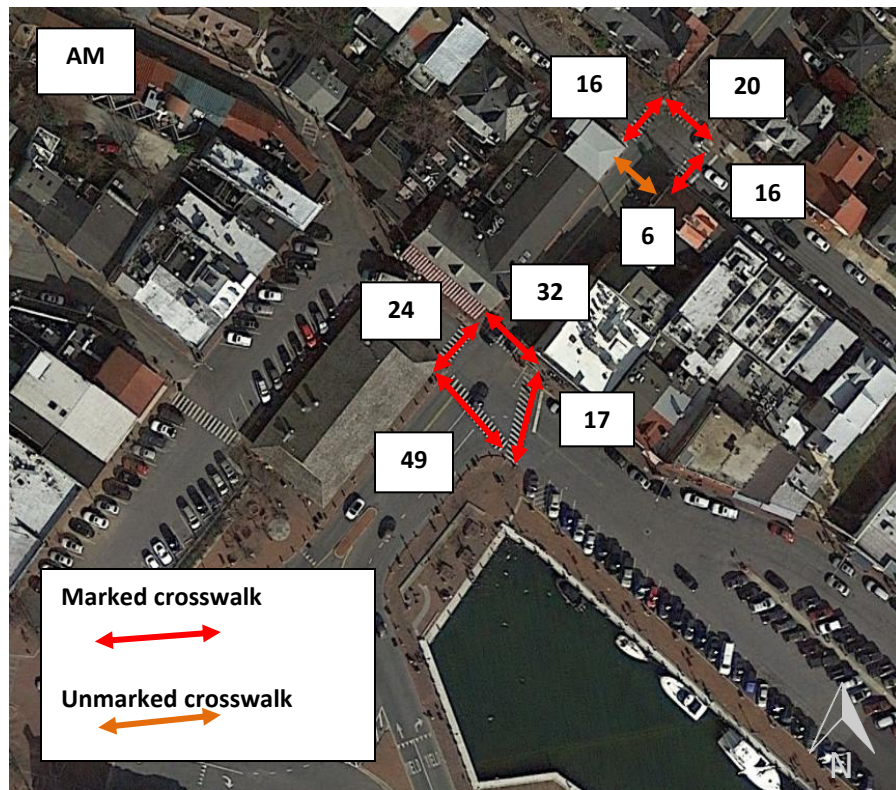




Figure 4: Total Pedestrian Volumes, PM peak vehicle hour (5:00 PM)

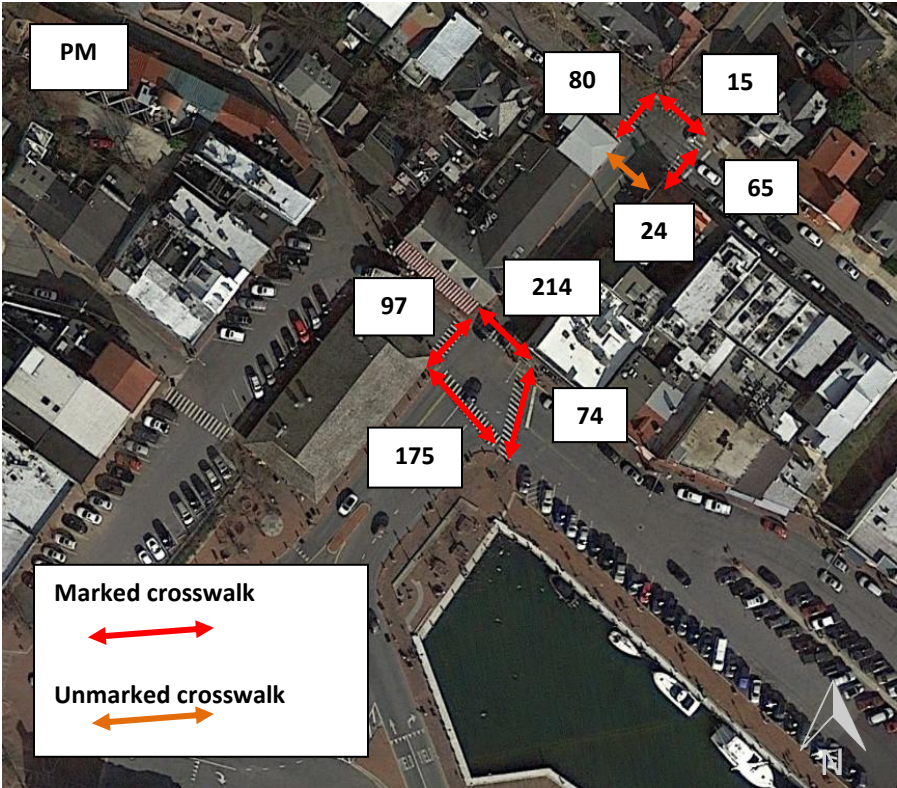


Figure 5: Saturday Total Pedestrian Volumes, peak vehicle hour (12:00 PM)

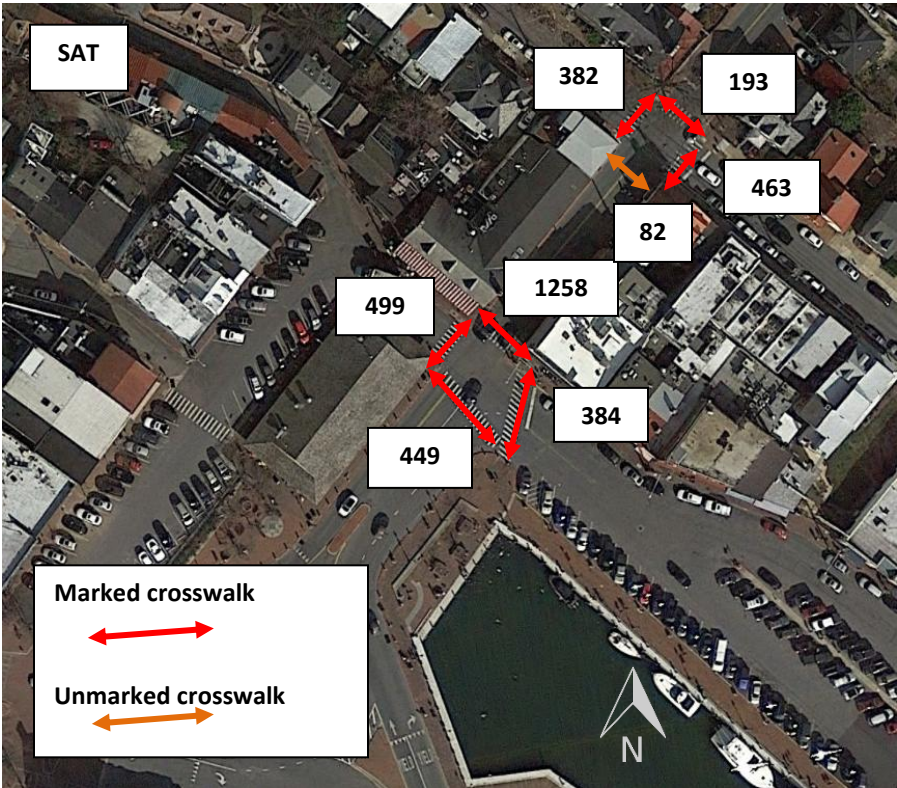
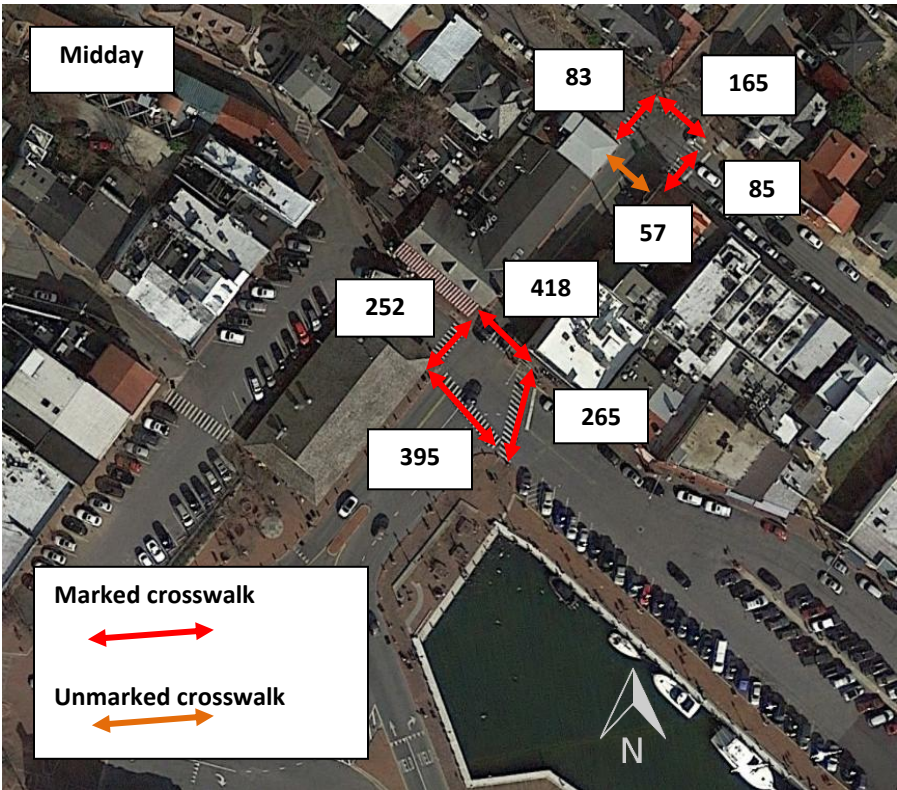




Figure 6: Weekday Peak Pedestrian Volumes (12:15 PM)



At Randall Street and Dock Street, vehicles entering the intersection increased throughout the day, while pedestrians entering the intersection peaked during midday. On Saturday, vehicle volumes were consistently lower than pedestrian volumes at the intersection. **Figures 7 and 8** depict vehicle and pedestrian volumes for Randall Street and Dock Street, for an average weekday and Saturday, respectively.



Figure 7: Weekday Vehicle and Pedestrian Volumes at Randall Street and Dock Street

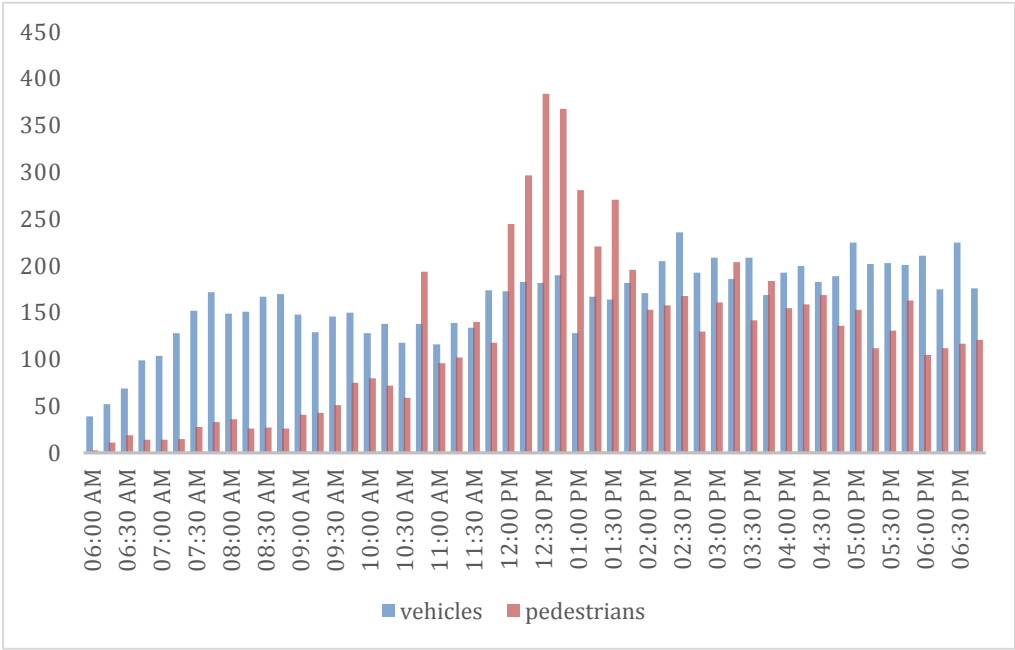
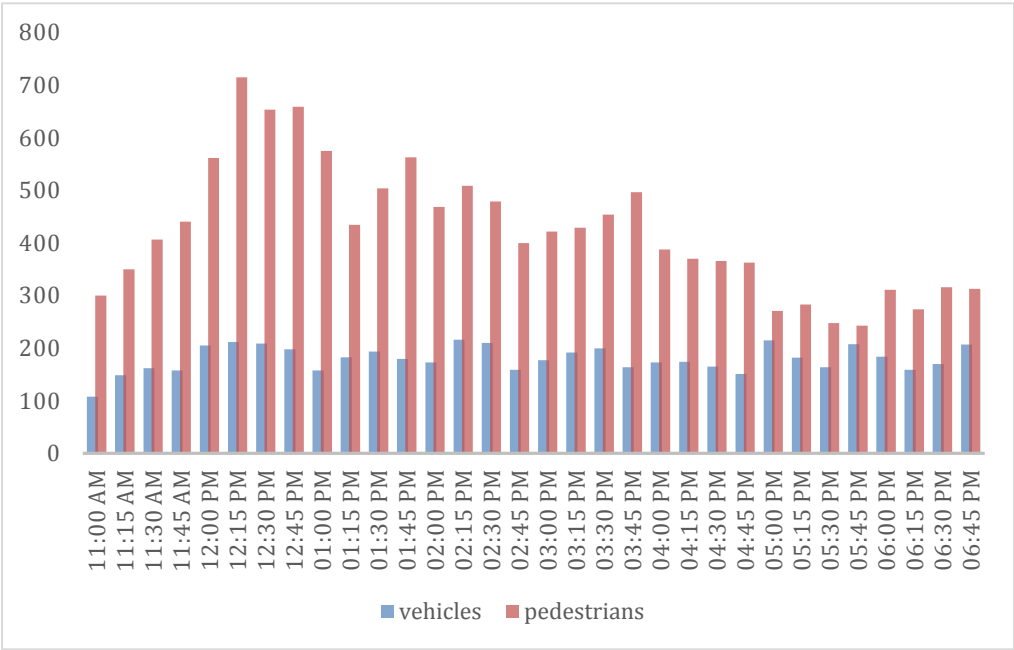


Figure 8: Saturday Vehicle and Pedestrian Volumes at Randall Street and Dock Street



At Randall Street and Prince George Street, vehicles entering the intersection increased throughout the day, while pedestrians entering the intersection peaked during midday, though pedestrian volumes never topped vehicle volumes. On Saturday, vehicle volumes were consistently lower than pedestrian volumes at the intersection prior to 2:00 PM. Pedestrian



volumes steadily decreased afterwards. **Figures 9 and 10** depict vehicle and pedestrian volumes for Randall Street and Prince George Street, for an average weekday and Saturday, respectively.

Figure 9: Weekday Vehicle and Pedestrian Volumes at Randall Street and Prince George Street

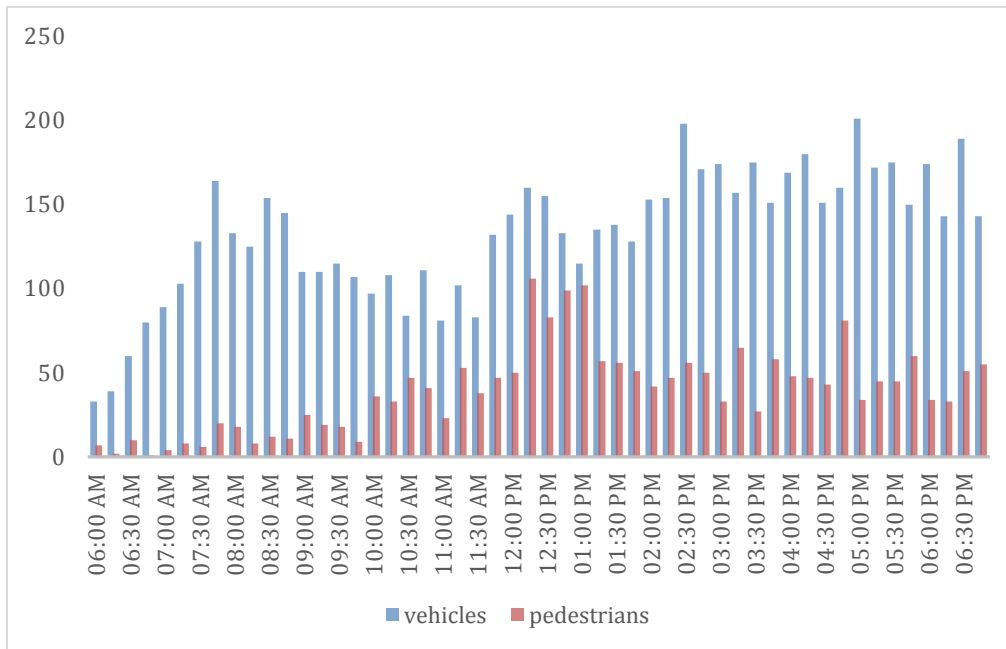
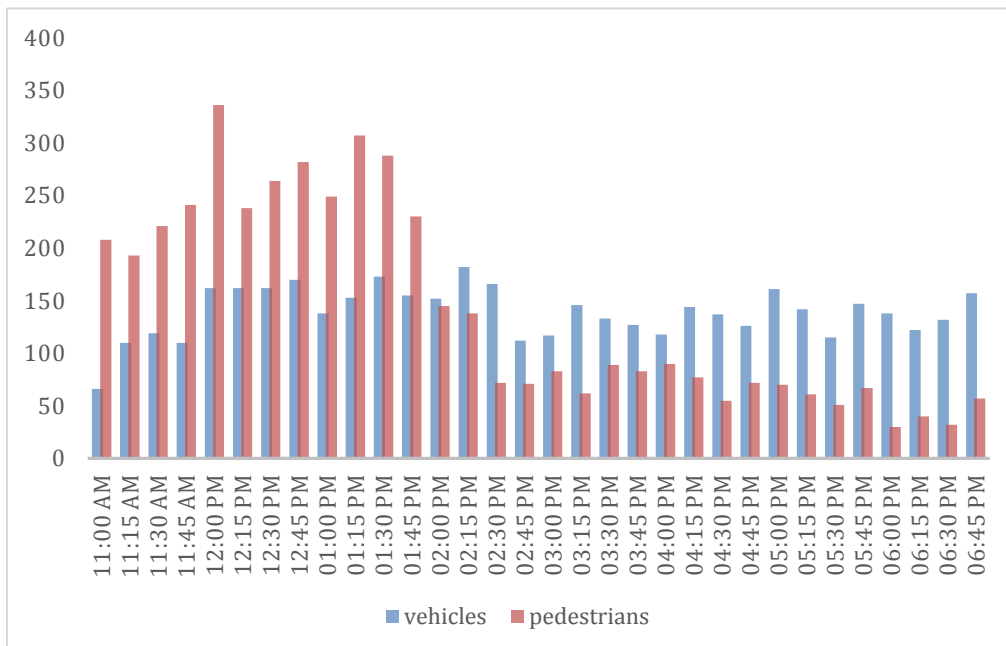


Figure 10: Saturday Vehicle and Pedestrian Volumes at Randall Street and Prince George Street



- 4) **Buses:** There are no bus stops or routes at the intersections of Randall Street/Dock Street or Randall Street/Prince George Street. However, the Green and Purple Routes travel through



Memorial Circle on Main Street and Compromise Street, with a stop at Compromise Street and St. Mary's Street. The Annapolis Circulator also travels through Memorial Circle and has a stop at Main Street and Green Street. Though no public buses travel north on Randall Street, the route is often used by private buses.

- 5) **Heavy Vehicles:** Delivery trucks often load and unload at the restaurants on Dock Street and Market Space, the majority of which arrive via the south leg of Randall Street at Dock Street. The maximum heavy vehicles (including delivery trucks) entering the intersection of Randall Street and Dock Street recorded in a given hour was 38, from 10:30 AM to 11:30 AM. At each of the peak periods, the recorded heavy vehicles were 13 (AM Peak), 10 (PM Peak), and 5 (Saturday Peak).
- 6) **Crash Experience:** Between January 1, 2015, and December 31, 2017, there were seven crashes at Randall Street and Dock Street (three in 2015, two in 2016, and two in 2017), and one crash at Randall Street and Prince George Street in 2017. There were no fatalities. Two collisions involved pedestrians; each of the three pedestrians hit were in the crosswalk. The other crash types for Randall and Dock Street include one left-turns, one angled, one parked, one rear-end, and one fixed object. One parked car was hit at Randall and Prince George Street. All crash types are summarized in **Tables 1 and 2**, and **Figure 11** depicts the location of each crash.

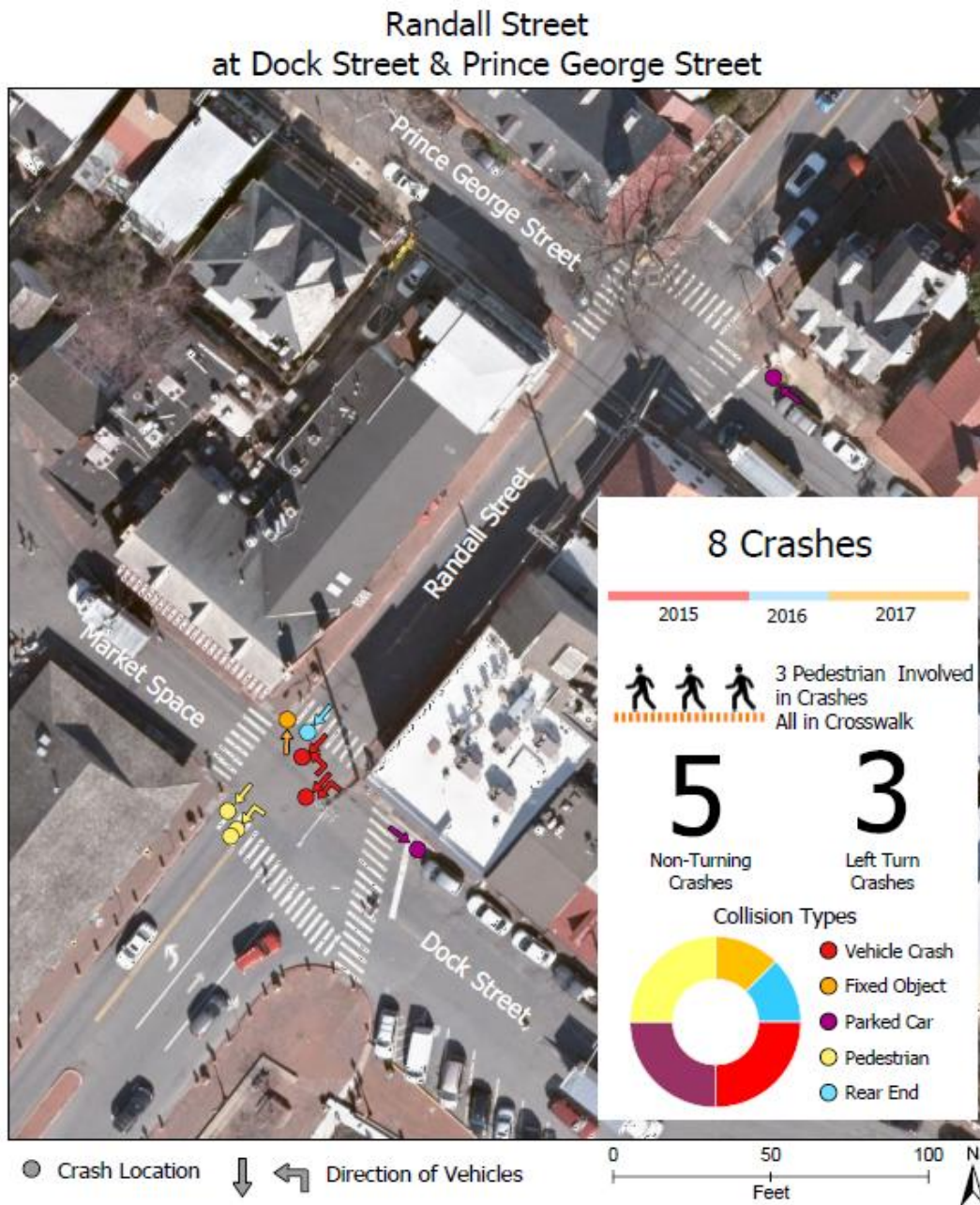
Table 1: Crash Summary, Randall Street and Dock Street

Time of Day	# of Crashes	Crash Type	# of Crashes
7:30 AM to 9:30 AM	0	Angle	1
9:30 AM to 11:30 PM	0	Left Turn (no peds)	1
11:30 AM to 1:30 PM	0	Rear End	1
1:30 PM to 4:00 PM	3	Sideswipe	0
4:00 PM to 6:30 PM	1	Parked/Fixed Object	2
6:30 PM to 7:30 AM	3	Pedestrian	2
		Bicycle	0
Total	7	Total	7
Reported Year	# of Crashes	Severity	# of Crashes
2015	3	Fatal	0
2016	2	Injury	2
2017	2	Property Damage Only	5
		Unknown	0
Total	7	Total	7

**Table 2: Crash Summary, Randall Street and Prince George Street**

Time of Day	# of Crashes	Crash Type	# of Crashes
7:30 AM to 9:30 AM	0	Angle	0
9:30 AM to 11:30 PM	0	Left Turn (no peds)	0
11:30 AM to 1:30 PM	0	Rear End	0
1:30 PM to 4:00 PM	1	Sideswipe	0
4:00 PM to 6:30 PM	0	Parked/Fixed Object	1
6:30 PM to 7:30 AM	0	Pedestrian	0
		Bicycle	0
Total	1	Total	1
Reported Year	# of Crashes	Severity	# of Crashes
2015	0	Fatal	0
2016	0	Injury	0
2017	1	Property Damage Only	1
		Unknown	0
Total	1	Total	1

Figure 11: Crash Diagram, Study Area



- 7) **Speed Limit:** The regulatory speed limit is 25 miles per hour on Randall Street, Dock Street, and Prince George Street. A “free-flow” spot speed study was conducted on northbound Randall Street between Dock Street and Prince George Street. Free-flow means that speeds were only recorded for vehicles that were able to clear both intersections without obstructions. The study was conducted between 8:00 AM and 9:00 AM, a period in which few people were observed walking in the study area and vehicle speed was assumed to be at its peak. The northbound direction was studied because of the observed sight distance issue for vehicles crossing Randall Street on Prince George Street (discussed in the following section) coupled with the potential for signal removal.



During the hour studied, 32 vehicles moved through both intersections without stopping. The 85th percentile speed of the sample pool was 23 miles per hour, with speeds ranging from 17 miles per hour to 29 miles per hour. Of the sample pool, only two vehicles were observed traveling at or above the speed limit. **Table 3** summarizes the observed vehicle speeds over the hour studied.

Table 3: Summary of Spot Speed Study

Direction	Regulatory Speed	Median Speed ¹	85 th Percentile ²	10 MPH Pace ³	% in Pace ⁴	Percent Enforceable ⁵
Northbound	25 mph	20 mph	23 mph	16-25 mph	97%	0%

1. Median speed is the speed at which an equal number of vehicles were traveling above and below.
2. The 85th percentile speed is the speed at which 85 percent of the vehicles were traveling below when unaffected by other vehicles. It is used by engineers as a good indication of the speed that the majority of motorists find safe and reasonable.
3. The 10 mile-per-hour pace is the range of speeds containing the greatest number of observed vehicles.
4. The percent in the 10 mile-per-hour pace reflects the percentage of vehicles that were traveling within this pace and is a good indicator of the range of speeds along a particular segment of roadway.
5. Percent enforceable refers to the percentage of vehicles traveling 10 mph or more above the speed limit.

- 8) **Sight Distance:** Minimum stopping sight distance and intersection sight distance are adequate at the intersection of Randall Street and Dock Street. However, at the intersection of Randall Street and Prince George Street intersection sight is limited for westbound vehicles on Prince George Street due to the buildings on Randall Street. **Table 4** depicts measured and required sight distance, for each leg of the intersection of Prince George Street and Randall Street, using the results from the Spot Speed Study. Note that Cases B1, B2, and B3 were evaluated for Randall and Prince George Street for the potential scenario wherein the signal is removed, and the intersection converted to stop-control.

Table 4: Measured and Calculated Sight Distances, Randall Street and Prince George Street

Maneuver	Minimum Sight Distance Calculation (ft)		Measured Sight Distance. SD (ft)	Met?	AASHTO ¹ Reference
	Regulatory Speed Limit: 25 mph	85 th Percentile Speed: 23 mph			
Stopping (NB Randall Street)	155	135	SSD = 160	Yes	Equations 3-2
Left Turn (NB Randall Street)	280	260	ISD = 190	No	Case B1/ Equation 9-1
Stopping (SB Randall Street)	155	135	SSD > 400	Yes	Equations 3-2

¹ AASHTO 2011, "A Policy on Geometric Design of Highways and Streets", 6th edition.



Right Turn and Crossing Maneuver (SB Randall Street)	240	220	ISD > 400	Yes	Case B2 and B3/ Equation 9-1
Stopping (WB Prince George Street)	240	220	SSD > 400	Yes	Equations 3-2
Left Turn (WB Prince George Street)	280	260	ISD = 152	No	Case B1/ Equation 9-1
Right Turn and Crossing Maneuver (WB Prince George Street)	240	220	ISD = 152	No	Case B2 and B3/ Equation 9-1

There are two sight distances that would not meet AASHTO requirements in the scenario where the traffic signal is removed: the left turn from Randall Street onto Prince George Street and all movements from Prince George Street onto Randall Street. If the traffic signal were to be removed, the intersection would require either geometric reconfiguration, conversion of the intersection to an all-way stop, or removal of the sight distance limitation.

- 9) **Queues, Delays, & Gaps:** Queues were observed in the southbound and northbound directions. Occasionally, the queue from Randall Street and Prince George Street would spill into the intersection at Randall Street and Dock Street. This was mostly observed on Saturday. The southbound queue at Randall Street and Dock Street was not significant, but the northbound queue would often stretch as far back as Compromise Street, as seen in the adjacent image. Delays were minimal at Randall Street and Prince George Street. Due to the high volume of pedestrians, northbound delays were often lengthy at Randall Street and Dock Street, lasting more than 30 seconds. Gaps were sufficient at Randall Street and Prince George Street to allow for turns. Though gaps were minimal at Randall Street and Dock Street, vehicles moved slowly enough that movements could be negotiated. **Table 5** summarizes observed northbound delays and queues for the intersection of Randall Street and Dock Street.



**Table 5: Summary of Field-Measured Delays at Randall Street and Dock Street**

Peak Hour	Approach	Total Delay (vehicle-hours) ²	Avg. Delay per Approach Vehicle (secs)	Avg. Delay per Stopped Vehicle (secs)	Maximum Observed Queue (vehicles)	Percent of Vehicles Stopped
AM	NB	0.01	0.4	15.0	2	3%
Midday	NB	3.00	100.0	100.0	18	100%
PM	NB	0.35	10.5	23.3	8	45%
Saturday	NB	1.05	32.4	40.3	12	81%

10) **Designated School Crossing:** Though the study location does not contain a designated school crossing (for example, the presence of a crossing guard or school crossing signs), it should be noted that Annapolis Elementary School is 0.1 miles away and St. Mary's Elementary and High Schools are 0.2 miles away.

11) **Field Observations:** A traffic engineer observed the intersection, specifically focusing on driver and pedestrian behavior, traffic patterns, geometry, and overall operations. Observations were made during peak periods; on Saturday, October 20th from 12:00 PM to 1:30 PM, Wednesday, October 24th from 4:30 PM to 6:00 PM, and Thursday, October 25th from 7:30 AM to 9:00 AM. The following summarizes the observations:

- Vehicles were observed yielding to pedestrians at the Randall Street and Dock Street crosswalks.



- During the observed Saturday hour and the peak vehicle surges, vehicles moved slowly enough through the Randall Street and Dock Street intersection. The intersection effectively operated as an all-way stop with drivers and pedestrians taking turns

- Occasionally, vehicles stopped at the red light at Prince George Street would spill south into the intersection of Randall Street and Dock Street, blocking movements from Dock Street onto Market Space and Randall Street (image to the left). There is room for approximately 6-7 vehicles in between Dock Street and Prince George Street.

- Prince George Street has only three crosswalks – there is no crosswalk on the south side of Prince George Street due to the presence of a utility pole.

² Note: vehicle-hours is the aggregated delay for each counted vehicle during a 15-minute interval within the peak hour. It is the standard metric used in measuring delay.



- Several vehicles were observed driving through the crosswalk at Randall Street and Dock Street before pedestrians completed crossing the street to the sidewalk
- Vehicles would occasionally drive into the intersection at Randall Street and Dock Street and then stop for pedestrians crossing at the far side crosswalk before clearing the intersection, as seen in the image to the right.
- A maximum queue of 14 vehicles was observed on northbound Randall Street during the Saturday peak hour. The queue extended from Dock Street through Memorial Circle. It took 33 seconds for the last car in the line-up to reach and clear the intersection.
- On Saturday, one van was observed illegally parked on Randall Street, obstructing the sight of pedestrians and turning cars on Dock Street for northbound drivers on Randall Street.
- A maximum of 5 bicycles were observed in a given peak hour. One Segway was also observed.
- Two pedestrians were observed crossing the intersection of Randall Street and Dock Street diagonally.
- Several packs of midshipmen were observed running during each peak period. One runner was observed running on Randall Street, in the street.
- When pedestrians were not present at the intersection of Randall Street and Dock Street, vehicles did not slow down driving through the intersection.
- Few unsupervised schoolchildren were observed in the study area during the morning and evening peak hours. None were observed in the morning, while several were observed in the afternoon.



- Two midblock pedestrian crossings were observed, between Dock Street and Memorial Circle. After crossing west, the pedestrians walked alongside the chain on the western side of Randall Street.
- The main morning traffic surge was from 7:50 – 8:00, where northbound vehicles on Randall Street were backed up passed Memorial Circle.
- One pedestrian was observed crossing through the lines of stopped vehicles in traffic at Randall Street and Dock Street
- During the morning peak hour, one truck was observed loading at Mission BBQ, blocking the view of southbound drivers for westbound Dock Street (image to the left).
- Few vehicles were observed on the east approach of Prince George Street; most vehicles that used Prince George Street were turning from Randall Street.



- 12) **Warrant Analysis Summary:** The traffic signal warrant analysis evaluation performed for the study intersection was based on the Maryland Manual on Uniform Traffic Control Devices (MD-MUTCD), 2011 Edition. Vehicle volumes are not high enough to meet any of the warrants for the installation of a full traffic signal at Dock Street or Prince George Street, but pedestrian volumes are high enough at Dock Street to warrant a full traffic signal. At Prince George Street, pedestrian volumes are not high enough to meet the pedestrian warrant.

Randall Street at Dock Street

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and Warrant #3 (Peak Hour Volume) have minimum requirements for vehicles per hour on both streets. These minimum volumes are **NOT MET** for any of the peak hours counted. *Warrant #4 (Pedestrian Volume)* requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street for either of four hours (criteria A) and a single hour (criteria B). There were 16 hours where pedestrians crossing the major street (Randall Street) exceeded the threshold required for Warrant 4 criteria A, and at thirteen hours where pedestrian volumes exceeded the requirement for criterion B. Warrant 4 is **MET**. *Warrant #5 (School Crossing)* is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is **NOT MET**. *Warrant #7 (Crash Experience)* requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. In order for the intersection to meet this warrant, all three conditions must be satisfied. The tables in the Interim Approval for Optional Use of an Alternative Signal Warrant 7 (IA-19) were also examined. Based on the three most recent years of available crash data, the minimum number of crashes has not occurred. Therefore, Warrant 7 is **NOT MET**. **Table 6** summarizes the applicable signal warrants for the intersection.

Table 6: Summary of Vehicle and Pedestrian Volumes, Randall Street at Dock Street

Start of Hour	Vehicle Volume on Randall Street	Vehicle Volume on Dock Street	Pedestrians Crossing Randall Street			Signal Warrants							
			Adults	School-age children	Bicycles	1a ¹	1b ²	80% 1a & 1b ³	2	3	4a	4b	7
7:00 AM	544	51	47	3	2	No	No	No	No	No	No	No	No
8:00 AM	620	85	78	2	1	No	No	No	No	No	No	No	No
9:00 AM	537	183	130	0	4	No	No	No	No	No	No	No	No
12:00 PM	690	164	578	204	3	No	No	No	No	No	Yes	Yes	No
1:00 PM	589	214	576	87	2	No	No	No	No	No	Yes	Yes	No



2:00 PM	748	233	382	8	1	No	No	No	No	No	Yes	Yes	No
3:00 PM	713	221	456	4	0	No	No	No	No	No	Yes	Yes	No
4:00 PM	719	179	399	4	2	No	No	No	No	No	Yes	No	No
5:00 PM	784	186	378	10	1	No	No	No	No	No	Yes	Yes	No
6:00 PM	753	79	260	13	2	No	No	No	No	No	Yes	No	No
11:00 AM (Sat)	523	229	861	47	0	No	No	No	No	No	Yes	Yes	No
12:00 PM (Sat)	765	250	1,654	53	1	No	Yes	No	No	No	Yes	Yes	No
1:00 PM (Sat)	660	239	1,091	151	0	No	No	No	No	No	Yes	Yes	No
2:00 PM (Sat)	688	321	1,153	99	1	No	No	No	No	No	Yes	Yes	No
3:00 PM (Sat)	647	306	1,134	90	4	No	No	No	No	No	Yes	Yes	No
4:00 PM (Sat)	588	291	946	64	0	No	No	No	No	No	Yes	Yes	No
5:00 PM (Sat)	701	320	636	61	0	No	No	No	No	No	Yes	Yes	No
6:00 PM (Sat)	625	229	766	77	0	No	No	No	No	No	Yes	Yes	No

1. Minimum traffic volumes are 500 vehicles on the major road AND 150 vehicles on the minor road.
2. Minimum traffic volumes are 750 vehicles on the major road and 75 vehicles on the minor road.
3. If 1a or 1b are not satisfied on their own, but each are satisfied at the 80% level of each. 80% of 1a is 400 and 120 vehicles, respectively, and 80% of 1b is 600 and 60 vehicles, respectively.

Randall Street at Prince George Street

Warrant #1 (Eight Hour Volume), Warrant #2 (Four Hour Volume), and Warrant #3 (Peak Hour Volume) have minimum requirements for vehicles per hour on both streets. These minimum



volumes are **NOT MET** for any of the peak hours counted. *Warrant #4 (Pedestrian Volume)* requires a minimum traffic volume and minimum corresponding pedestrians per hour crossing the major street. The highest volume of pedestrians crossing the major street (Randall Street) in one hour did meet the minimum thresholds of 107 and 133 pedestrians per hour (criteria A and B, respectively); however, the corresponding vehicle volumes are not high enough for the warrant to be satisfied. Warrant 4 is **NOT MET**. *Warrant #5 (School Crossing)* is intended for application where schoolchildren cross the major street at a designated school crossing. The intersection is not located within a school zone; therefore, Warrant 5 is **NOT MET**. *Warrant #7 (Crash Experience)* requires five or more reported crashes, minimum volumes, and testing of alternatives before warranting a traffic signal. In order for the intersection to meet this warrant, all three conditions must be satisfied. The tables in the Interim Approval for Optional Use of an Alternative Signal Warrant 7 (IA-19) were also examined. Based on the three most recent years of available crash data, the minimum number of crashes has not occurred. Therefore, Warrant 7 is **NOT MET**. **Table 7** summarizes the applicable signal warrants for the intersection.

Table 7: Summary of Vehicle and Pedestrian Volumes, Randall Street at Prince George Street

Start of Hour	Vehicle Volume on Randall Street	Vehicle Volume on Prince George Street	Pedestrians Crossing Randall Street			Signal Warrants							
			Adults	School-age children	Bicycles	1a ¹	1b ²	80% 1a & 1b ³	2	3	4a	4b	7
7:00 AM	470	63	11	0	0	No	No	No	No	No	No	No	No
8:00 AM	539	71	22	1	0	No	No	No	No	No	No	No	No
9:00 AM	414	138	15	0	1	No	No	No	No	No	No	No	No
12:00 PM	525	264	79	104	0	No	No	No	No	No	No	No	No
1:00 PM	467	217	62	28	0	No	No	No	No	No	No	No	No
2:00 PM	611	267	36	0	2	No	No	No	No	No	No	No	No
3:00 PM	594	213	47	2	2	No	No	No	No	No	No	No	No
4:00 PM	617	147	41	0	1	No	No	No	No	No	No	No	No
5:00 PM	667	172	39	0	1	No	No	No	No	No	No	No	No
6:00 PM	602	97	34	0	0	No	No	No	No	No	No	No	No
11:00 AM (Sat)	338	261	186	3	0	No	No	No	No	No	No	No	No
12:00 PM (Sat)	582	298	258	17	0	No	No	No	No	No	No	No	No



1:00 PM (Sat)	537	354	212	20	0	No	No	No	No	No	No	No	No
2:00 PM (Sat)	529	294	90	16	0	No	No	No	No	No	No	No	No
3:00 PM (Sat)	460	263	86	14	6	No	No	No	No	No	No	No	No
4:00 PM (Sat)	448	333	88	7	0	No	No	No	No	No	No	No	No
5:00 PM (Sat)	490	262	64	4	0	No	No	No	No	No	No	No	No
6:00 PM (Sat)	492	135	39	0	0	No	No	No	No	No	No	No	No

1. Minimum traffic volumes are 500 vehicles on the major road AND 150 vehicles on the minor road.
2. Minimum traffic volumes are 750 vehicles on the major road and 75 vehicles on the minor road.
3. If 1a or 1b are not satisfied on their own, but each are satisfied at the 80% level of each. 80% of 1a is 400 and 120 vehicles, respectively, and 80% of 1b is 600 and 60 vehicles, respectively.

13) **Multi-way Stop Summary:** The installation of an all-way stop at the intersection of Randall Street and Prince George Street was examined following guidance from Section 2B of the 2011 MUTCD. According to the MUTCD, an all-way stop can be considered if:

- A. It is an interim measure for the installation of a traffic control signal.
- B. Five or more crashes susceptible to correction by a multi-way stop were reported.
- C. The following minimum volumes are met:
 1. The vehicular volume entering the intersection from the major street approaches averages at least 300 vehicles per hour for any 8 hours, and
 2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches averages at least 200 units per hour for the same 8 hours, and
 3. The average delay to minor-street vehicular traffic is at least 30 seconds per vehicle during the highest hour.
 4. If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.
- D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

The intersection of Randall Street and Prince George Street does not meet the initial MUTCD criteria. Considering a traffic signal is already installed at the intersection, Criterion A can be excluded. Two crashes were reported during the most recent three years; therefore, Condition B is not met. The vehicular volume entering the intersection from the major street exceeds 300 vehicles for the majority of the day; however, the combined vehicular, pedestrian, and bicycle entering the intersection from the minor street only exceeds 200 units at midday, little delay was reported, and speeds are well below 40 mph. Condition C is not met.



In addition to the previous listed guidelines, the MUTCD provides other optional criteria that may be considered when performing an engineering study, including:

- A. The need to control left-turn conflicts
- B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes.
- C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop
- D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.

The intersection of Randall Street and Prince George Street is located in a residential neighborhood with sidewalks where residents walk, and it is adjacent to a major commercial area (Annapolis City Dock). Parking exists on Prince George Street, and pedestrians may walk from their cars to Annapolis City Dock and Historic Downtown. As both vehicle and pedestrian circulation are high, Option B is satisfied. The available intersection sight distance from the east approach on Prince George Street is inhibited by the buildings on Randall Street. Requiring both directions to stop before proceeding through the intersection allows drivers a view of conflicting traffic; therefore, Option C is satisfied. While the majority of traffic on Randall Street makes the through movement, a sizeable amount of vehicles also turn onto Prince George Street. A stop sign would help vehicles negotiate movements; Option D is satisfied.

- 14) **Existing Capacity Analysis:** Capacity analyses were performed for both study intersections under existing and alternative conditions. The intersection of Randall Street and Dock Street is stop-controlled at Dock Street, while the intersection of Randall Street and Prince George Street is a currently a pretimed signal. During the AM and PM peak hours, the signal operates with a cycle length of 55 seconds.

Existing Conditions

An existing capacity analysis was performed using Synchro 9 and HCM methodology. Results indicate poor operations for the east leg, and satisfactory operations for the north and south legs. However, the methodology used by Synchro 9 forces pedestrians to yield to vehicles, rather than reality of the intersection which is the other way around. Though only stop-controlled at Dock Street, the intersection of Randall Street and Dock Street practically resembles a three-way stop, due to the continuous flow of pedestrians on each leg. Accordingly, results for the north and south legs show significantly less delay than what actually occurs, while Saturday's high volume of pedestrians on the east leg of the intersection entirely inhibits vehicle movement (represented as "Error" in the HCM 2000 results). **Table 8** shows the existing operations for the east leg of the intersection, modeled as a four-way stop.



Table 8: Existing Operations at Dock Street, Westbound Leg

Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Westbound	15.0	26.8	Error	0.04	0.24	4.16	B	D	F	3	22	Error

Level of Service (LOS) for the north and south legs of the intersection can be better represented by the field-measured delay (from Table 5), using the following reference from the HCM for unsignalized intersections:

Control Delay (sec)	LOS
0 -10	A
>10 - 15	B
>15 - 25	C
>25 - 35	D
>35 - 50	E
>50	F

Table 9 summarizes the LOS for the critical northbound approach during each peak period at Randall Street and Dock Street based on field-measured delays.

Table 9: Summary of LOS for Randall Street and Dock Street, Northbound Leg

Approach	Delay (sec/veh)				Level of Service			
	AM	Midday	PM	Sat	AM	Midday	PM	Sat
Northbound	0.4	100.0	10.5	32.4	A	F	B	D

Based on northbound approach delay, the intersection of Randall Street and Dock Street operates at failing service at Midday, which is the weekday pedestrian peak period.

Tables 10 provides a summary of the results of the existing capacity analysis at Randall Street and Prince George Street, performed using Synchro 9 and Highway Capacity Manual (HCM) 2000 methodology. The delay, volume-to-capacity ratio, level of service, and 95th-percentile queue lengths (in feet) are shown for each approach and the overall intersection.

Table 10: Summary of Existing Capacity Analysis, Randall Street and Prince George Street

Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Overall	5.3	5.8	6.5	0.25	0.30	0.30	A	A	A	-	-	-



Westbound	18.3	18.4	19.5	0.07	0.08	0.19	B	B	B	23	26	48
Northbound	4.8	5.1	4.7	0.31	0.34	0.28	A	A	A	70	75	61
Southbound	4.4	5.3	5.0	0.23	0.36	0.33	A	A	A	47	78	67

SUMMARY OF FINDINGS

The study area exists in the heart of Historic Annapolis, adjacent to City Dock and many more of the City's commercial attractions. As such, it is frequented by a wide variety of travel modes, including vehicle, pedestrian (walkers and runners), bicycle, Segway, and private bus. Often, pedestrian volumes surpass vehicles, especially during the weekday midday peak and throughout the day on Saturday. Ensuring safe and comfortable travel conditions is paramount to maintaining a thriving downtown culture.

Observations and analysis of the study area have produced the following key takeaways:

- The field-measured vehicle speeds for vehicles moving at “free-flow” were most often below the regulatory speed limit.
- There have been five crashes at Randall and Dock Street within the past three years that could have been corrected by a traffic signal. In two of those crashes, three pedestrians were involved.
- The intersection of Randall Street and Dock Street operates at LOS F during the weekday midday peak.
- A full traffic signal is warranted at Randall Street and Dock Street based on Warrant #4, Pedestrian Volumes.
- Intersection sight distance is not adequate for vehicles crossing or turning onto Randall Street from Prince George Street with the intersection's current geometry. If the traffic signal were to be removed either 1) geometric reconfiguration, conversion of the intersection to an all-way stop, or removal of the sight distance limitation (not practical) should would be necessary to provide AASHTO required sight distances.

Based on these takeaways, it is recommended to install a traffic signal at the intersection of Randall Street and Dock Street and maintain the existing traffic signal at Randall Street and Prince George Street. Several concepts were developed that would result in operational and safety improvements for the study area, explored in the following section.



Alternative Concepts

Alternatives for the study area include four versions of a signalized intersection at Randall Street and Dock Street, two which incorporate new geometric configurations, one with existing roadway geometry, and one incorporating fully actuated vehicle detection.

For all proposed alternatives, the signal with Prince George Street is assumed to be coordinated with the signal at Dock Street. Both options will be presented.

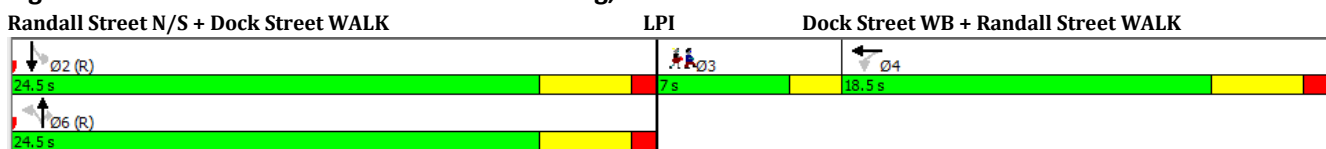
Due to the cyclical nature of pedestrian activity, it is recommended that a traffic signal at Randall Street and Dock Street have a non-peak pedestrian timing scheme and a peak pedestrian timing scheme. **Table 11** depicts an example schedule for each timing variation at Randall Street and Dock Street, based on pedestrian counts in the study area.³

Table 11: Phasing Schedule, Randall Street and Dock Street

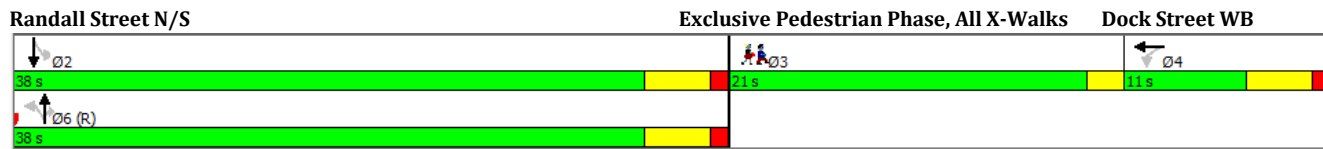
Day	Time	Phasing
Weekday	11:00 PM – 10:00 AM	Non-Peak
Weekday	10:00 AM – 11:00 PM	Peak
Weekend/Holiday	12:00 AM – 9:00 AM	Non-Peak
Weekend/Holiday	9:00 AM – 12:00 AM	Peak

Though each set of signal phasing varies by cycle length and splits, there is a common thread; “Non-Peak” pedestrian phasing employs a Lead Pedestrian Interval (LPI) and “Peak” pedestrian phasing employs an exclusive pedestrian phase. An LPI gives pedestrians a “head start” at the beginning of a phase, before vehicles are permitted to enter the intersection. They can vary in length depending on the site-specific characteristics. Differences in signal timing between the four alternatives stem from the variance in intersection geometry and the presence of detection. **Figures 12** and **13** show an example of the phasing at Randall Street and Dock Street for the two types of phasing.

Figure 12: Randall Street and Dock Street Phasing, Non-Peak Pedestrian Period



³ Note: exact time of day pattern and plan hours will vary by season and event schedule

**Figure 13: Randall Street and Dock Street Phasing, Peak Pedestrian Period**

Alternative 1: Pretimed Traffic Signal at Randall Street and Dock Street

Alternative 1 provides pretimed signal control for Randall Street and Dock Street using current road geometry. **Table 12** provides a summary of the capacity analysis for Alternative 1; the AM peak employs non-peak pedestrian signal timing, while PM, and Saturday use peak pedestrian signal timing. The cycle length assumed for the traffic analysis of both intersections is 50 seconds for the AM peak period, 70 seconds for the PM peak period, and 70 seconds for the Saturday peak period.

Table 12: Summary of Alternative Scenario 1

Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Randall Street and Dock Street												
Overall	11.4	13.3	13.7	0.26	0.31	0.27	B	B	B	-	-	-
Westbound	13.2	32.4	30.0	0.03	0.20	0.23	B	C	B	13	42	48
Northbound	12.7	12.4	12.9	0.49	0.41	0.24	B	A	A	127	*147	124
Southbound	8.7	11.8	2.6	0.35	0.50	0.30	A	A	A	42	98	120
Randall Street and Prince George Street												
Overall	2.7	3.7	5.5	0.24	0.26	0.26	A	A	A	-	-	-
Westbound	16.6	24.1	23.4	0.07	0.08	0.17	B	C	C	21	31	53
Northbound	0.6	0.7	0.7	0.29	0.29	0.25	A	A	A	0	1	1
Southbound	4.3	4.8	5.4	0.22	0.31	0.30	A	A	A	41	75	74

*Queue exceeds storage capacity



Alternative 2: Pretimed Traffic Signal at Randall Street and Dock Street with Bump-outs and Channelized Right

Alternative 2 provides pretimed signal control for Randall Street and Dock Street with the addition of bump-outs at three corners of the intersection (shown in **Figure 14**). **Table 13** provides a summary of the capacity analysis for Alternative 2 the AM peak employs non-peak pedestrian signal timing, while PM and Saturday use peak pedestrian signal timing. The cycle length assumed for the traffic analysis of both intersections is 50 seconds for the AM peak period, 70 seconds for the PM peak period, and 70 seconds for the Saturday peak period.

Table 13: Summary of Alternative Scenario 2

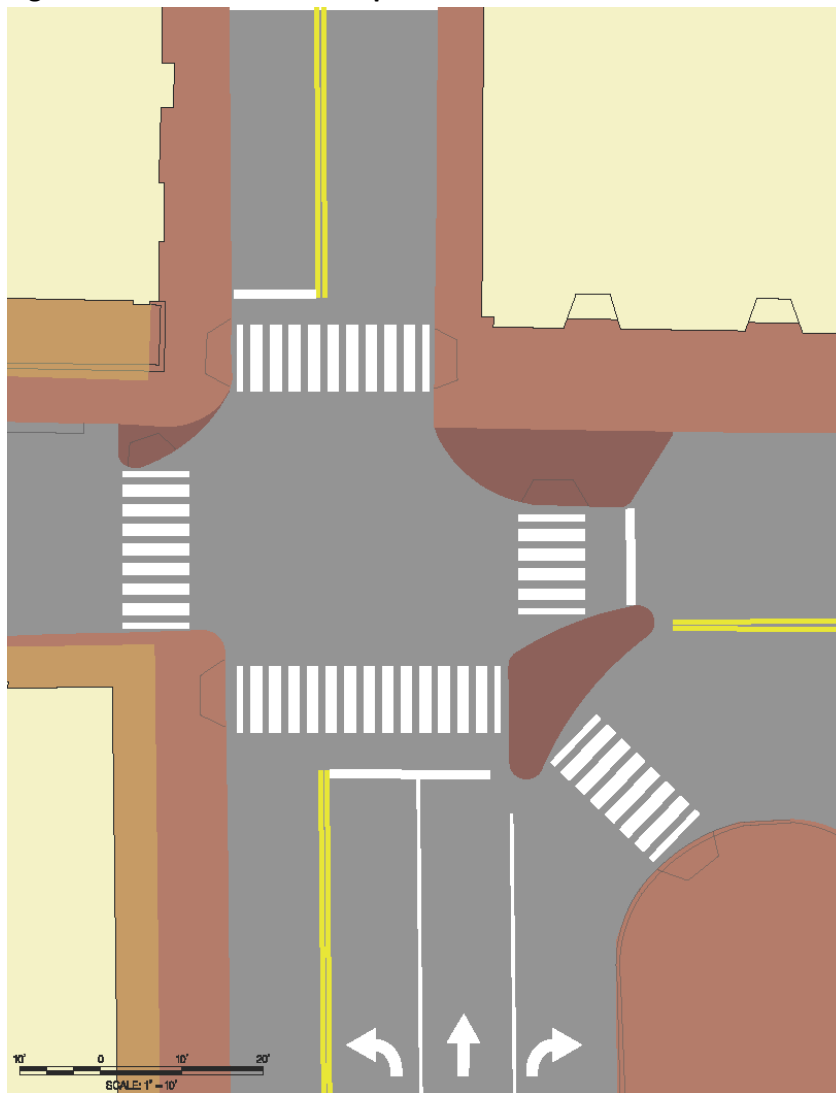
Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Randall Street and Dock Street												
Overall	6.9	9.3	11.5	0.27	0.31	0.40	A	A	B	-	-	-
Westbound	17.7	30.6	37.6	0.05	0.18	0.38	B	C	D	16	41	#60
Northbound	7.6	8.2	10.1	0.38	0.36	0.31	A	A	B	98	122	105
Southbound	4.9	7.8	8.6	0.28	0.44	0.43	A	A	A	30	52	47
Randall Street and Prince George Street												
Overall	2.9	3.8	5.5	0.24	0.26	0.26	A	A	A	-	-	-
Westbound	16.6	24.1	23.4	0.07	0.08	0.17	B	C	C	21	31	53
Northbound	0.8	0.8	0.8	0.29	0.29	0.25	A	A	A	2	1	1
Southbound	4.3	4.8	5.4	0.22	0.31	0.30	A	A	A	41	75	64

95th percentile volume exceeds capacity, queue may be longer

In this alternative, three curb modifications are recommended for the intersection of Randall Street and Dock Street, on the northeast, northwest, and southeast corners. The bump-outs create additional curb space, which will reduce pedestrian crossing distance, provide pedestrian refuge, enhance intersection safety, and provide additional space for traffic signal infrastructure. **Figure 14** shows the proposed concept for Alternative 2.



Figure 14: Alternative 2 Concept for Randall Street and Dock Street



The concept was developed using a WB-40 as the design vehicle, per field observations and discussions with the City and nearby businesses. The dimensions of the WB-40 mimic the delivery trucks that frequent the restaurants on Dock Street. The dimensions for the intersection were developed using Auto-Turn, with the WB-40 as the input vehicle. **Figure 15** shows the result of the Auto-Turn analysis.

[illegible]



Alternative 3: Pretimed Traffic Signal at Randall Street and Dock Street + Reducing Northbound Randall Street from Three Lanes to Two Lanes

Alternative 3 provides pretimed signal control for Randall Street and Dock Street and reduces the three lanes on the south leg of Randall Street to two lanes. The south leg of Randall Street would instead have a left-turn lane and a through-right lane. **Table 14** provides a summary of the capacity analysis for Alternative 1; the AM peak employs non-peak pedestrian signal timing, while PM and Saturday use peak pedestrian signal timing. The cycle length assumed for the traffic analysis for both intersections is 50 seconds for the AM peak period, 70 seconds for the PM peak period, and 70 seconds for the Saturday peak period. The signals at the two intersections are coordinated.

Table 14: Summary of Alternative Scenario 3

Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Randall Street and Dock Street												
Overall	6.7	12.1	16.9	0.29	0.36	0.47	A	B	B	-	-	-
Westbound	26.1	34.9	34.4	0.07	0.28	0.35	C	C	C	21	43	51
Northbound	7.3	12.2	19.0	0.37	0.51	0.69	A	B	B	113	*176	*233
Southbound	4.2	8.7	10.0	0.23	0.46	0.44	A	A	A	32	115	143
Randall Street and Prince George Street												
Overall	3.0	3.8	5.7	0.22	0.26	0.26	A	A	A	-	-	-
Westbound	24.0	24.1	23.4	0.07	0.08	0.17	C	C	C	27	31	53
Northbound	0.7	0.9	1.1	0.26	0.29	0.25	A	A	A	2	4	m5
Southbound	4.1	4.8	5.4	0.20	0.31	0.30	A	A	A	47	75	74

*Queue exceeds storage capacity

m Volume for 95th percentile queue is metered by upstream signal



Alternative 4: Actuated-Coordinated Traffic Signal at Randall Street and Dock Street

This alternative adds vehicular detection to the traffic signal operations. Vehicle detection will enable the traffic signal to operate more efficiently from a vehicular perspective. For example, when there is light traffic on Dock Street, the signal will not provide the full green time allocated, but only the time needed to serve the few vehicles waiting to turn onto Randall Street. **Table 15** summarizes the capacity analysis of an actuated-coordinated scenario for the two study intersections. The cycle length assumed for the traffic analyses, for both intersections is 50 seconds for the AM peak period, 70 seconds for the PM peak period, and 70 seconds for the Saturday peak period.

Table 15: Summary of Alternative 4

Approach	Synchro 9 (HCM2000) Results											
	Delay (sec/veh)			v/c Ratio			Level of Service			95 th -% Queues		
	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat	AM	PM	Sat
Randall Street and Dock Street												
Overall	3.9	8.0	12.1	0.26	0.31	0.27	A	A	B	-	-	-
Westbound	21.6	34.2	33.3	0.10	0.34	0.37	C	C	C	13	41	48
Northbound	3.8	6.4	11.3	0.29	0.31	0.32	A	A	B	*137	*147	124
Southbound	2.8	6.5	10.3	0.21	0.38	0.40	A	A	B	52	*175	*151
Randall Street and Prince George Street												
Overall	4.4	3.5	5.0	0.24	0.26	0.29	A	A	A	-	-	-
Westbound	16.3	26.1	29.3	0.07	0.11	0.32	B	C	C	21	32	61
Northbound	3.5	2.9	0.7	0.29	0.27	0.24	A	A	A	0	1	36
Southbound	4.3	3.0	3.0	0.22	0.29	0.28	A	A	A	41	60	63

*Queue exceeds storage capacity

Alternative 5: Signal Removal/ Minor Street Stop Sign along Prince George Street at Randall Street

Based on the signal warrant analysis, a signal is not warranted at Randall Street and Prince George Street based on pedestrian and vehicle volumes. If the existing traffic signal is removed, a stop sign can be installed on westbound Prince George Street. A stop sign would be installed in conjunction with the restriping of street markings, which include the following:

- The stop bar should be moved up approximately 3.5 feet to enable enhanced sight distance for vehicles on Prince George Street.





- All faded crosswalks should be restriped for increased visibility and re-aligned. Per the image to the right, the crosswalks are currently faded and misaligned with the geometry of the street corners.

Recommendations

The City of Annapolis requested an evaluation of various traffic control operations at Randall and Dock Streets to enhance pedestrian safety and traffic operations. Several alternatives with variations in signal timing/phasing and geometric design were developed and tested that were found to be feasible, summarized in **Table 16**. Alternative 2 is recommended for further design and construction.

Table 16: Advantages/Disadvantages of Each Alternative

Alternative	Advantages	Disadvantages
Alternative 1: Pretimed Traffic Signals at Randall Street and Dock Street, Randall Street and Prince George Street	<ul style="list-style-type: none"> • Faster to implement than other alternatives because it does not include geometric modifications • Lowest cost 	<ul style="list-style-type: none"> • Lack of space to install traffic signal and pedestrian signal equipment; may require exceptions to the MUTCD. • There are no bump-outs in this option. The bump-outs provided some additional space for pedestrians to wait while the WALK signal is displayed. Without this additional space, pedestrians may overflow on the sidewalks and roadways. • Does not decrease the time pedestrians must spend crossing the street PM northbound queue exceeds storage capacity
RECOMMENDED Alternative 2: Pretimed Traffic Signal at Randall Street and Dock Street, Randall Street and Prince George Street; Bump-outs with right turn channelization at Randall Street and Dock Street	<ul style="list-style-type: none"> • Best overall performance of alternatives in terms of traffic operations, pedestrian mobility and pedestrian safety • Greatest reduction of northbound queue out of the alternatives • Bump-outs allow pedestrians to cross the shortest distance, reducing pedestrian exposure to traffic. Bump-outs have a speed mitigating effect 	<ul style="list-style-type: none"> • Mid-High cost • Lengthy implementation • Construction will impede current traffic flow and limit foot traffic • Poorest westbound traffic conditions compared to other alternatives • Pedestrian crossings at the right channelization may result in back-ups similar to current conditions



Alternative 3: Pretimed Traffic Signal at Randall Street and Dock Street, Randall Street and Prince George Street; Reducing Northbound Randall Street from Three Lanes to Two Lanes	<ul style="list-style-type: none"> Creates more space for pedestrians in an area of the City where pedestrians often outnumber vehicles. This may also include facilities for bicycles and public art 	<ul style="list-style-type: none"> Highest cost Lengthy implementation Construction will impede current traffic flow and limit foot traffic Poorest overall performance compared to other alternatives Randall Street queues at Dock Street exceed storage capacity during the PM and Saturday peak periods
Alternative 4: Actuated-Coordinated Traffic Signals at Randall Street and Dock Street, Randall Street and Prince George Street	<ul style="list-style-type: none"> More efficient flow of traffic for northbound and southbound vehicles; least delay, shortest queues and less spillage into and beyond Memorial Circle Easy installation with low disruption 	<ul style="list-style-type: none"> Highest delays for westbound vehicles High cost: installation and maintenance AM and PM northbound queues exceed storage capacity, PM and Saturday southbound queues exceed storage capacity Lack of space to install traffic signal and pedestrian signal equipment; may require exceptions to the MUTCD. There are no bump-outs in this option. The bump-outs provided some additional space for pedestrians to wait while the WALK signal is displayed. Without this additional space, pedestrians may overflow on the sidewalks and roadways. Does not decrease the time pedestrians must spend crossing the street
Alternative 5: Pretimed Traffic Signal at Randall Street and Dock Street; Signal Removal/ Minor Street Stop Sign along Prince George Street at Randall Street	<ul style="list-style-type: none"> Lower maintenance than a traffic signal Low cost 	<ul style="list-style-type: none"> Greater potential for vehicle conflicts than a traffic signal Would not operate well with the proposed traffic signal at Randall Street and Dock Street